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Incidental Capture of Sea Turtles in Shrimp Trawls With and Without TEDs in U.S. Atlantic and Gulf Waters

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Five species of endangered or threatened sea turtles inhabit the Gulf of Mexico and Atlantic Ocean. These are the loggerhead (*Caretta caretta*), green (*Chelonia mydas*), Kemp's ridley (*Lepidochelys kempii*), hawksbill (*Eretmochelys imbricata*), and leatherback (*Dermochelys coriacea*). The olive ridley (*L. olivacea*) occasionally occurs in the Atlantic. All are legally protected by the United States Endangered Species Act of 1973. Sea turtles are caught incidentally in shrimp trawls, and these captures have been identified as the major source of sea turtle mortality in the Gulf of Mexico and along the U.S. Atlantic coast (Magnuson et al., 1990). In these areas, Henwood and Stuntz (1987) estimated turtle capture and mortality rates for loggerheads, Kemp's ridleys, and green turtles from a variety of shrimp trawl data collected between 1973 and 1984. Turtle mortality was estimated at 9874 per year for loggerheads, 767 per year for Kemp's ridleys, and 229 per year for greens. Overall capture rates per year for these species were approximately four times higher than their mortality rate. Magnuson et al. (1990) considered the mortality of turtles in shrimp trawls to range from 5000 to 50,000 per year for loggerheads and 500 to 5000 per year for Kemp's ridleys. Information on actual observed captures and catch rates of sea turtles remains relatively scarce, especially regarding incidental catches in trawls equipped with a TED (Trawling Efficiency Device or Turtle Excluder Device) or BRD (Bycatch Reduction Device). The intent of this note is to estimate catch rates of turtles in shrimp trawls, excluding try nets, with and without TEDs in U.S. waters.

Methods. — The National Marine Fisheries Service (NMFS) has conducted two shrimp trawling studies since 1988 in which sea turtles were captured incidentally. The first study (TED study), from March 1988 through September 1990, compared the effects of TEDs on shrimp catch by commercial shrimp trawlers in the southern North Atlantic and Gulf of Mexico (Renaud et al., 1993). Typically, vessels pulled 2 or 4 standard nets (TED-less nets) for 2–6 hrs and intermittently sampled with a smaller try net. Try nets were not equipped with TEDs. Observers recorded shrimp catch during trawling operations. Gear specialists modified the standard nets so that shrimp catch among the nets was nearly equivalent. Then TEDs were installed into half of the standard nets and adjusted to have the least impact, if any, on

Table 1. Number of turtles captured by net-type and by turtle condition during the TED study by the National Marine Fisheries Service Laboratory, Galveston, Texas. AC = alive and conscious, AU = alive and unconscious, SA = slid out of mouth of net, conscious alive, SN = slid out of mouth of net, turtle not moving, FD = fresh dead, DD = decomposed dead, STD = standard net, TRY = try net, TED = TED-equipped net.

	By Turtle Condition						By Net-Type			
Species	AC	AU	SA	SN	FD	DD	STD	TRY	TED	Total
Loggerhead	32	6	7	1	3	2	42	6	3	51
Kemp's ridley	11	4	0	0	1	0	16	0	0	16
Leatherback	1	0	0	0	0	0	1	0	0	1
Green	1	0	0	0	0	0	1	0	0	1
Hawksbill	1	0	0	0	1	0	2	0	0	2
Unknown	0	0	1	0	0	0	1	0	0	1
Totals	**46**	**10**	**8**	**1**	**5**	**2**	**63**	**6**	**3**	**72**

shrimp catch of the net. Renaud et al. (1990, 1991) detail the methodology for this work. The second study (bycatch study), still in progress, was implemented in April 1992 when TED regulations were in effect for offshore waters (areas seaward of U.S. Coast Guard defined COREG lines). TEDs were present in all nets except during a brief suspension of TED regulations off the Louisiana coast from 4 September to 5 October 1992. Bycatch in the U.S. shrimp fishery in the Gulf of Mexico and along the U.S. Atlantic coast was characterized by TED-type during commercial operations. Catch of turtles (number/hr/100 ft of trawl headrope), by TED-type and overall, was determined independently for each study and separately for the Atlantic and Gulf of Mexico. Since the time a try net was in the water was not typically recorded, catch rates for try nets could not be calculated during this analysis.

Results and Discussion. — Loggerhead, Kemp's ridley, green, hawksbill, and leatherback turtles were caught during normal fishing operations in these studies (Table 1). Seventy-two turtles were taken in 6478 hours of trawling during the TED study. Sixty-three turtles were caught in standard shrimp trawls, 6 in try nets, and 3 in TED-equipped nets. Three loggerheads, one Kemp's ridley, and one hawksbill were landed freshly dead. Two loggerheads, in an advanced state of decomposition, were excluded from the catch per unit effort analyses.

Total catch rate (turtles/hour/100 ft of trawl head rope), excluding try nets, was 0.00075 in the Gulf of Mexico and 0.00718 in the Atlantic (Table 2). Out of the 6 TEDs tested, turtles were only observed captured in the Super Shooter TED. These catch rates were 0.00022 turtles/hr in the Gulf of Mexico and 0.00185 in the Atlantic (Table 2).

Forty-five turtles were taken in 18,631 hours of trawling during the bycatch study from April 1992 through October 1995 (Table 3) (J. Nance and L. Scott-Denton, unpubl. data). Twenty-four turtles were captured in TED-equipped nets and 19 in try nets. Two turtles were captured in nets without TEDs. One loggerhead and 2 Kemp's ridleys were landed freshly dead. Three decomposed turtles (1 loggerhead, 1 Kemp's ridley, and 1 unidentified) were excluded from the catch per unit effort analysis. Total catch rates for trawls

Table 2. Turtle catch per unit of effort (number of turtles/100 ft of headrope of trawl/hour) (CPUE) for various net-types in the Atlantic and Gulf of Mexico during the TED study by the National Marine Fisheries Service, Galveston, Texas[1].

Area	TED-type	Number of Tows	Number of Turtles	Hours	CPUE
Atlantic					
	Golden	5	0	15.6	0.00000
	Morrison	34	0	88.1	0.00000
	Georgia	365	0	1777.9	0.00000
	Super Shooter	270	2	1083.0	0.00185
	Standard[2]	681	50	4277.7	0.01169
	Total	**1355**	**52**	**7242.4**	**0.00718**
Gulf of Mexico					
	Anthony Weedless	21	0	23.9	0.00000
	Saunders	91	0	194.3	0.00000
	Georgia	257	0	1643.6	0.00000
	Super Shooter	673	1	4626.6	0.00022
	Standard[2]	996	12	10835.2	0.00111
	Total	**2038**	**13**	**17323.6**	**0.00075**

[1] Six turtles (5 alive and 1 decomposed) captured in try nets and one decomposed turtle captured in a standard net were excluded from these analyses.

[2] Standard nets do not have TEDs.

(turtles/hour/100 ft of trawl head rope), excluding try nets, were 0.00016 in the Gulf of Mexico and 0.00047 in the Atlantic. Turtles were captured in 8 of 13 known TED-types used by shrimpers (Table 4). Captures by TED-type ranged from 0.00009 turtles/hr with Georgia Jumper and Morrison Soft TEDs in the Gulf of Mexico (Table 4) to 0.01685 turtles/hr with Anthony Weedless TEDs in the Atlantic. Five TED-types captured no turtles during the study.

Incidentally captured turtles ranged in size from a 23 cm straight carapace length (SCL) hawksbill to a 163 cm SCL leatherback. Excluding 4 decomposed and 4 unidentifiable turtles, the most commonly captured species was the loggerhead ($n = 75$; 69%), followed by the Kemp's ridley ($n = 23$; 21%), leatherback ($n = 6$; 5%), green ($n = 3$; 3%), and hawksbill ($n = 2$; 2%). Four turtles were not identified to species. Turtle conditions included alive and conscious, alive and unconscious, freshly dead, and dead and decomposed (Tables 1 and 3). Seventy-seven turtles were captured off the coasts of North Carolina, Georgia, and eastern

Table 3. Number of turtles captured by net-type and by turtle condition during the shrimp bycatch study by the National Marine Fisheries Service Laboratory, Galveston, Texas. AC = alive and conscious, AU = alive and unconscious, SA = slid out of mouth of net, conscious alive, SN = slid out of mouth of net, turtle not moving, FD = fresh dead, DD = decomposed dead, STD = standard net, TRY = try net, TED = TED-equipped net.

	By Turtle Condition						By Net-Type			
Species	AC	AU	SA	SN	FD	DD	STD	TRY	TED	Total
Loggerhead	17	0	6	1	2	1	0	16	11	27
Kemp's ridley	3	0	2	0	2	1	2	1	5	8
Leatherback	2	0	0	3	0	0	0	1	4	5
Green	2	0	0	0	0	0	0	1	1	2
Unknown	0	0	1	1	0	1	0	0	3	3
Totals	**24**	**0**	**9**	**5**	**4**	**3**	**2**	**19**	**24**	**45**

Table 4. Turtle catch per unit of effort (number of turtles/100 ft of headrope of trawl/hour) (CPUE) for various TED-types in the Atlantic and Gulf of Mexico during the bycatch study[1].

Area	TED-type	Number of Tows	Number of Turtles	Hours	CPUE
Atlantic					
	Mini Super Shooter	22	0	18.2	0.00000
	Andrew's 8"	9	0	188.2	0.00000
	Standard[2]	94	0	195.6	0.00000
	Super Shooter	104	0	681.3	0.00000
	Burbank	141	0	1,831.9	0.00000
	Morrison	253	1	3,993.9	0.00025
	Georgia	392	3	5,709.3	0.00053
	Anthony Weedless	66	2	118.7	0.01685
	Total	**1,081**	**6**	**12,737.2**	**0.00047**
Gulf of Mexico					
	Alario	18	0	49.1	0.00000
	Unknown Hard Grid	21	0	421.2	0.00000
	Matagorda	72	0	626.5	0.00000
	Andrew's 5	104	0	2,363.6	0.00000
	Weedless Design	95	0	2,992.2	0.00000
	Not Recorded	154	0	6,031.9	0.00000
	Super Shooter	766	2	27,335.1	0.00007
	Georgia	660	2	21,439.6	0.00009
	Morrison	284	1	11,307.4	0.00009
	Andrew's 8"	214	2	8,806.6	0.00023
	Anthony Weedless	438	4	11,426.5	0.00035
	Taylor	209	3	8,374.0	0.00036
	Busken	128	2	3,788.8	0.00053
	Standard[2]	291	1	1,977.2	0.00051
	Total	**3,454**	**17**	**106,939.6**	**0.00016**

[1] Nineteen turtles captured in try nets and three decomposed turtles were excluded from these analyses.
[2] Standard nets do not have TEDs.

Florida, 25 off the west coast of Florida, and 15 elsewhere in the Gulf of Mexico.

Single or multiple captures of a sea turtle in a shrimp trawl or trawls may result in the turtle's injury or death and its subsequent stranding on the beach. Caillouet et al. (1991) found highly significant correlations between strandings of sea turtles and shrimping effort in the nearshore waters of Texas and southwestern Louisiana. Manzella et al. (1988) documented the capture of 2 Kemp's ridleys in shrimp trawls, their release, and recapture by other vessels. One of these turtles subsequently stranded alive in poor condition. This provides some confirmation of the theory that turtle strandings may be a result of turtles incidentally captured and released alive by the shrimp fishery.

The activities of man have had severe impacts on sea turtles over the past five decades. The most notable has been on the Kemp's ridley sea turtle. During the 1940s, as many as 40,000 turtles nested in a day at Rancho Nuevo, Mexico (Hildebrand, 1963). Now, less than 1000 nest in an entire season (R. Byles, *pers. comm.*). This reduction in the number of nesters has been attributed to long-term egg collecting in Mexico and to trawlers in USA and Mexico (Byles et al., in press). Present day activities of man that harm sea turtles include commercial shrimp trawling, gill netting and longlining, recreational fishing with hook and line, injuries caused by encounters with boat hulls and propellers, dredging of navigable waterways, explosive removal of offshore oil and gas structures, and entanglement in marine debris (Magnuson et al., 1990). With respect to sea turtle mortality, Magnuson et al. (1990) concluded that the U.S. shrimp fishery was responsible for ten times more turtle deaths than the next closest cause (all other fisheries combined: finfish trawls, seines, gill nets, traps, and longlines). This ongoing problem must be continually addressed to prevent local extirpation of these marine reptiles.

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